954 Applications of Transesophageal Echocardiography in Atrial Fibrillation

Tuesday, March 21, 1995, Noon–2:00 p.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: Noon–1:00 p.m.

TUESDAY PM

954-1 Cost-Effectiveness of Early Cardioversion Guided by Transesophageal Echocardiography for Hospitalized Patients with Atrial Fibrillation

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Transesophageal echo (TEE)-guided early cardioversion has been proposed as a strategy for hospitalized patients with new atrial fibrillation (AF). Such an approach would serve to minimize the cost/risk of anticoagulation and eliminate the need for a second hospitalization for cardioversion at the cost/risk of TEE. To evaluate the cost-effectiveness of the TEE approach, we examined the cost per quality-adjusted life year (QALY) for 4 strategies: I) anticoagulation for 1 mo followed by cardioversion; II) transthoracic echo (TTE) and 1 mo anticoagulation followed by cardioversion; III) TTE, with TEE if TTE (–); 1 mo anticoagulation if TTE (+) or TEE (+); and IV) no TTE; initial TEE with 1 mo anticoagulation if TEE (+); early cardioversion if TEE (–). All strategies are assumed to include 1 mo of anticoagulation following cardioversion. The baseline assumed risk of thromboembolism was 0.8% for all strategies. The hemorrhagic risk was assumed at 0.96% for the first mo and 0.32% the second mo of anticoagulation. We used costs rather than hospital charges.

Results: TEE-guided early cardioversion [without initial TTE; *Strategy IV*] dominates all other strategies in that it is the least costly and most effective. Current conventional therapy [*Strategy II*] costs over $400/pt more, without change in QALY. Sensitivity analysis indicates that the hemorrhagic risk drives the analysis, but the results are stable over a broad range of risks and costs, including a 2/3rds reduction in the hemorrhagic complication rate. There would also be no change in the outcome if the initial TTE were eliminated from conventional therapy.

Conclusion: TEE-guided early cardioversion (without initial TTE) is both the least expensive and the most effective strategy for hospitalized patients with new AF. Future trials studying the use of TEE for treatment of new AF should consider elimination of the initial TTE study and careful assessment of hemorrhagic complications.

954-2 Transesophageal Echocardiographic and Clinical Predictors for Outcome of Cardioversion of Atrial Fibrillation

Patrick M.J. Verhorst, Roelof C. Welling, Otto Kamp, Cees A. Visser. *Free University Hospital, Amsterdam, NL*

To determine the value of transesophageal echo (TEE) and clinical variables in predicting outcome of cardioversion (CV), we studied 62 patients with nonvalvular atrial fibrillation (AF), who underwent TEE prior to elective electrical CV. We measured left atrial (LA) size, mitral valve annulus (MVA) width, LA appendage (LAA) size and LAA peak flow velocity (pfv), and evaluated presence of LA spontaneous contrast (LASC) and severity (none-mild/moderate-severe) of MV regurgitation (MVR). After CV, sinus rhythm (SR) was restored in 50 patients (81%) and maintained in 29 patients (58%) at 1 year follow-up.

Results:

	Initial Outcome		1 Year Outcome		
	AF (n = 12)	SR (n = 50)	AF (n = 21)		SR (n = 29)
LA size (cm^2)	23.3 ± 7.4	22.6 ± 6.7	26.4 ± 5.0	*	19.8 ± 6.5
MVA width (cm)	3.8 ± 0.3	3.9 ± 0.3	4.0 ± 0.2	*	3.7 ± 0.3
LAA size (cm^2)	7.8 ± 2.7	8.8 ± 3.9	9.3 ± 3.3		8.4 ± 3.3
LAA-pfv (cm/s)	22 ± 9	29 ± 15	19 ± 8	*	36 ± 15
LASC presence	5	17	13	**	4
MVR severity	7/5	38/12	16/5		22/7

*p < 0.0001, **p < 0.005

Outcome was not related to age, gender, etiology of AF, or use of antiarrhythmic drugs. In contrast, duration of AF was of influence on 1 year outcome: AF vs. SR: 6.7 ± 7.3 vs. 2.0 ± 2.4 months; (**).

Conclusions:

No TEE or clinical variables predict initial success of CV of AF. However, 1 year after initial success, LA size, MVA width, LASC, duration of AF, and particularly LAA-pfv, are highly related to the maintenance of SR.

954-3 Usefulness of Contrast Transesophageal Echocardiography in Identification of Increased Risk of Cardiogenic Embolism in Nonvalvular Atrial Fibrillation

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Anatomical and functional informations about the left atrial appendage (LAA) obtained by transesophageal echocardiography (TEE) are contributory to evaluate a risk of cardiogenic embolism (CE) in nonvalvular atrial fibrillation (NVAF). This study was designed to further characterize a subgroup of NVAF pts with an increased risk of CE with the use of contrast TEE. In 33 NVAF pts, 15 were complicated by CE and 18 were not. Twelve age-matched healthy subjects were studied as control. Albunex 0.1 ml/kg was injected intravenously and the contrast echo enhancement in the left atrium was recorded by TEE on a video tape. Non opacified area in LAA (Ao) and LAA area were measured in end-systole, and the ratio of Ao to LAA area (Ao ratio) was obtained as a mean of 5 consecutive measurements. *Results:* In healthy subjects, the contrast agent produced complete opacification of LAA, thus Ao ratio was 0%. While, Ao ratio was 52 ± 9% and 31 ± 6% in NVAF with CE and without CE, respectively ($p < 0.001$). Ao ratio over 40% was 80% sensitive and 78% specific for identifying CE group, and the positive predictive value was 75%. *Conclusion:* In NVAF, the echo contrast agent did not opacify LAA entirely. Non opacified area of transpulmonary contrast agent in LAA as measured by TEE, probably reflecting the extent of blood stagnation in LAA more directly, may be a new useful index for identification of a subgroup of NVAF pts with an increased risk of CE.

954-4 The "Swirling" Pattern of Atrial Spontaneous Echo Contrast can be Characterized by Integrated Backscatter Using Fourier Analysis

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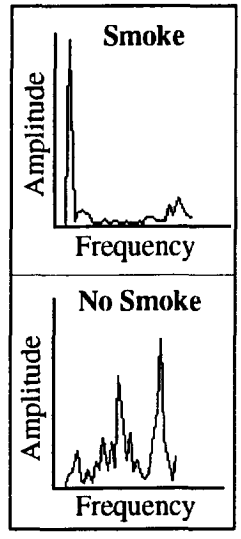
Atrial spontaneous echo contrast (smoke) refers to dynamic smoke-like echos that has both increased intensity and a distinctive "swirling" pattern. We have previously shown that smoke can be measured by integrated backscatter (IBS) intensity, and now hypothesize that the swirling pattern could be characterized by frequency spectrum analysis of IBS sequences by Fast Fourier Transformation (FFT).

Methods: We acquired IBS sequences during TEE in 25 pts. who had been qualitatively assessed independently for smoke severity. We analyzed IBS intensity of the LA smoke region, as well as reference intensity sequences from the left ventricular cavity (LV) and the interatrial septum (IAS), for 60 consecutive frames at 30 Hz under optimal imaging gains. We calculated FFT centroid frequencies to characterize the shape and distribution of the frequency pattern for all acquired IBS sequences.



Results: Mild and severe LA smoke IBS sequences were characterized by low dominant frequency with high amplitude variability, whereas the no smoke, LV, and IAS sequences were characterized by high frequency with low amplitude variability, consistent with random interframe noise. The mean FFT centroid frequency for atrial smoke sequences (6.2 ± 2.7) was significantly lower than the centroid frequency for no-smoke sequences (11.9 ± 4.1; $p < 0.001$). Total IBS variance (integral of all non-zero components) was

significantly associated with the qualitative grade of atrial smoke ($p < 0.003$).

Conclusions: 1) Analysis of IBS FFT spectra shows that atrial smoke is a unique echocardiographic phenomenon, clearly distinguishable from either artifact or tissue; 2) IBS intensity analysis and IBS FFT frequency analysis each provide an objective quantitative measure of smoke which may serve to assess thrombogenic potential and embolic risk in patients with spontaneous echo contrast.

954-5 Pre-cardioversion Transesophageal Echocardiography as a Predictor of Unsuccessful Electrical Cardioversion of Atrial Fibrillation

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To assess the utility of transesophageal echocardiography (TEE) pre-cardioversion (CV) of atrial fibrillation (AF) as a predictor of unsuccessful CV (no reversion or recurrence <24 h.), 68 patients with AF and atrial flutter (8) were studied. Mean aged was 61 ± 9 years. TEE was performed before CV. Left atrial (LA) and left atrial appendage (LAA) size, spontaneous echo contrast (SCE) grade (from 0 to 3) and mechanical function were evaluated. We measured LAA emptying velocities (+) and total wave velocity (T = emptying + filling waves). LAA flow was classified in 6 patterns (IA, IB, II, IIIA, IIIB, IV): detected in sinus rhythm (I), flutter (II), AF (III), and no identifiable flow waves (IV). The patterns IB, IIIB, and IV represented LAA mechanical disfunction, and were defined by an emptying wave less than 20 cm/sec.

Results: 14 patients had recurrent AF 24 h. after CV. The remaining patients were in sinus rhythm. There were no differences between both groups with regard to aged, mitral stenosis prevalence, functional class, atrial flutter, LA size and LAA dimension and history of embolization. In contrast, the unsuccessful group had longer duration of AF, higher SEC grade and higher mechanical disfunction.

CV	N	LA		LAA			
		SCE	SCE (2–3)	SCE	(+)	(T)	(IIIB–IV)
Unsuccessful	14	1.5 ± 1	71%	1.3 ± 0.9	26	54	74%
Successful	51	1.1 ± 1	43%*	0.9 ± 1.1	35	72	43%*

*$p < 0.05$

LA spontaneous echo contrast grade 2–3 and/or LAA IIIB–IV flow pattern had a diagnostic sensibility of 79%, specificity 60%, positive predictive value 35%, and negative 91% for unsuccessful CV.

Conclusions: TEE performed pre-CV is useful in detecting patients with higher probability of unsuccessful CV. Higher LA disfunction with spontaneous echo contrast grade 2–3 and/or higher LAA mechanical disfunction (IIIB–IV) with spontaneous echo contrast grade 2–3, was found in this group of patients. All this can be helpful to select patients for CV.

954-6 Evidence of Deterministic Chaos in Atrial Fibrillation as Demonstrated by Fourier Spectral Analysis of Left Atrial Appendage Doppler Flow

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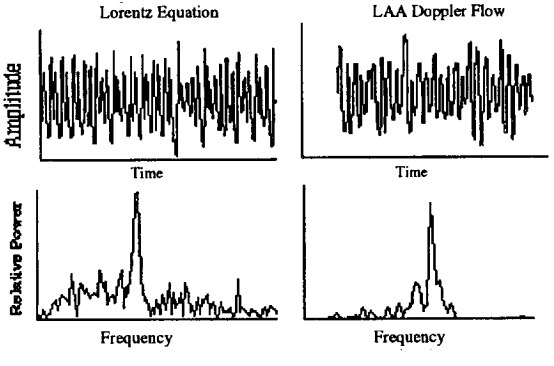
Theories of deterministic chaos have been applied to mammalian systems and specifically to arrhythmogenesis however controversy persists as to whether fibrillation [atrial (AF) or ventricular] obeys the laws of dynamical chaos. We addressed this question by analyzing the frequency spectra of left atrial appendage (LAA) Doppler flow in AF (n = 17), describing these spectra using fractions or multiples of the dominant frequency (D_f) or by a function of two basic frequencies (f) along with their harmonics and frequency combinations ($mf_1 \pm nf_2$), and correlating these signals with a mathematical



model for deterministic chaos using the Lorentz equations. Spectral analysis demonstrated a mean D_f of 6.3 ± 0.7 Hz (range 5.6–7.8 Hz) which was associated with a wide range of subharmonics (12% to 59% of total spectral power, avg 32 ± 12%). Three patients exhibited very narrow based spectral patterns with very little subharmonics. Twelve of 17 LAA Doppler fourier spectra (71%) could be defined by the equation $mf_1 \pm nf_2$. The transition to a chaotic state was modeled by solving the Lorenz equations, with the solutions and Fourier transform of the signal exhibiting striking similarity to the signal generated by LAA Doppler flow as well as to the Fourier spectra of LAA flow in AF.

Conclusions: (1) Fourier analysis of LAA Doppler flow in AF demonstrates behavior consistent with deterministic chaos in most but not all cases. (2) Mathematical modeling of a chaotic system closely resembles LAA flow in AF. Fourier analysis of LAA flow should provide insight into structural and electrophysiologic mechanisms of AF.

954-7 Cardioversion of Atrial Flutter: Atrial Appendage Stunning and Thromboembolic Potential. A Transesophageal Echocardiographic Study

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Cardioversion (CV) of atrial arrhythmias is commonly performed. Pericardioversion anticoagulation is not recommended in patients with atrial flutter (AFL) as it is assumed that the thromboembolic potential of atrial flutter is extremely low. To determine the thromboembolic potential of patients with atrial flutter undergoing cardioversion, we performed transesophageal echocardiography (TEE) in 26 consecutive patients (25 electrical and 1 pacing) immediately prior to and immediately after cardioversion. 2 patients experienced cerebrovascular events within 24 hours of cardioversion despite the absence of thrombi on the precardioversion TEE. Peak left atrial appendage outflow (LAA+) and inflow velocities (LAA−, cm/sec) prior to (PRE) and after (POST) cardioversion were documented (mean ± SD):

	LAA+	LAA−
PRE CV	53 ± 19.6	53.2 ± 20.6
POST CV	30 ± 16.1	38.7 ± 18.1
p <	0.0001	0.0001

92% of patients demonstrated a reduction in LAA+; 58% of patients had a greater than 50% decrease in LAA+. 50% of patients developed new or increased spontaneous echo contrast after cardioversion. Both patients with new cerebrovascular accidents demonstrated marked reductions in LAA+ and increased spontaneous echo contrast.

Conclusion: Patients undergoing CV of AFL have evidence of significant left atrial appendage stunning. Stunning after CV as evidenced by decreased left atrial appendage velocities and increased spontaneous echo contrast is common and associated with thromboembolism. Anticoagulation should be considered in patients undergoing CV of atrial flutter with high risk TEE indices.

955 New Intravenous Contrast Agents for Myocardial Opacification

Tuesday, March 21, 1995, Noon–2:00 p.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: 1:00 p.m.–2:00 p.m.

955-54 Adjunctive Techniques Enable Myocardial Opacification by Intravenous Injection of Reduced Doses of QW3600 (EchoGen®)

Oi Ling Kwan, Bruno Cotter, Youngmei Cha, Shiro Nozaki, Constance Calisi, Anthony N. DeMaria. *University of California at San Diego, CA*

QW3600 (EG) is a new perflourocarbon (dodecaflouropentane) ultrasonic contrast agent capable of producing myocardial opacification by IV injection. However, the doses required for myocardial visualization have sometimes been associated with transient hemodynamic changes. Therefore, we evaluated the ability of pretreatment with: (1) antihistamines and corticosteroids to eliminate hypersensitivity and thus reduce hemodynamic changes; and (2) administration of coronary vasodilators to enhance myocardial intensity. We performed 2-D echo in the short axis parasternal view in 10 closed chest ventilated dogs in whom LV, Ao and pulmonary artery catheters enabled direct assessment of hemodynamics. All animals were given benadryl 1 mg/kg and Solu-Mediol 1 mg/kg approximately one hour prior to the study. Subsequently, a 0.5 cc/kg EchoGen® injection was repeated. Contrast intensity was quantified by a 0.3 cm^2 region of interest positioned in the midventricular